



获奖证书

CERTIFICATE OF AWARD

作品名称: safe fingers Leader in the hand rehabilitation industry/手复科技
——手部复健行业领航者

在中国国际大学生创新大赛 (2023) 中荣获铜奖

参赛学生: Wei Liu、Jiachen Yu、Jiahan Zhou、Yuxuan Shen、Hongru Shen、
Ruiqi Mo、Qianfan Wang

指导教师: 董桂丽、陈正伟、甄丽平、朱雅萍、郑章琦

主办单位:

教育部、中央统战部、中央网信办、国家发展改革委、
工业和信息化部、人力资源社会保障部、农业农村部、
中国科学院、中国工程院、国家知识产权局、国家
乡村振兴局、共青团中央、天津市人民政府

中国国际大学生创新大赛组委会

二〇二三年十二月

证书编号: 20232182Z

手复

safetingers

Leader in hand rehabilitation industry

手部复健行业领航者



- International Lane（国际赛道）
- Category: Undergraduate Creativity Group
- Founder: Liu Wei
- School: Zhejiang University of Science and Technology



Project Introduction/项目简介

Safe fingers

- Development for 2 years
- The company will be established in August, 2023
- Committed to becoming a leader in hand rehabilitation

5 invention patents
5项发明专利

5 invention patents
2 authorized
2项已授权
1 team member as the
first inventor
1项成员为第一发明人

3 main products
3个主打产品

Hardware manipulator
硬件机械手
Basic rehabilitation system
基础复健系统软件
Customized Solution
定制化康复方案

3 intent purchase agreements
3家意向采购单位

HuaAn Medical
华安医疗 Risheng
Medical 日盛医
疗
Haipei instruments
海沛仪器

vocational certification
行业认证

Special Approval
Procedures for Class II
Innovative Medical
Devices
符合《第二类创新医疗器械
特 别审批程序》



R&D history/研发历程



Health talk at basketball club
团队创始人在篮球俱乐部的健康讲座上产生了康复机械手的想法



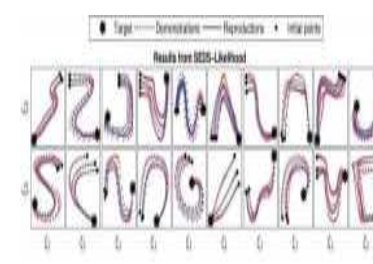
local hospitals in France
团队走访法国当地医院复健中心，调研欧美医院复健现状



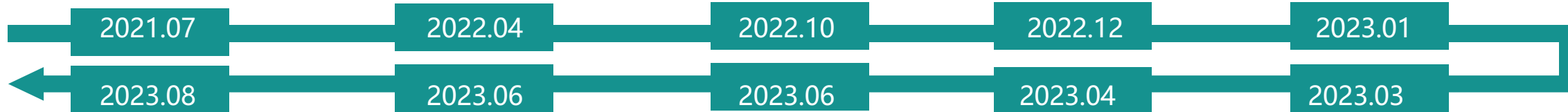
Rehabilitation hospitals in Hangzhou
团队成员也走访了杭州市的多家康复医院和理疗机构



Doctor hand 1.0
提出了第一代康复机械手模型并做了样机



Skill parameterized imitation learning algorithms
开发技能参数化的模仿学习算法并召集志愿者采集大量样本数据



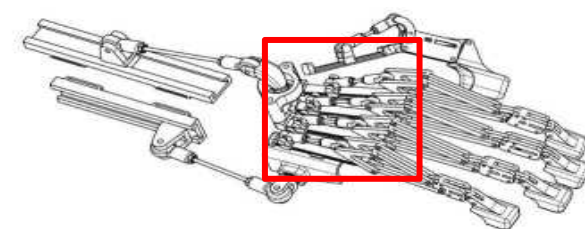
Company registration
拟于2023.08成立公司

Cooperate with Hangzhou Haipai and Risheng Medical Company
与杭州海沛仪器、日盛医疗公司合作

Cooperate with Hangzhou Huan Medical Co., Ltd
与杭州华安医疗公司合作

Launched to residential areas
投放到若干住宅小区试用

Doctor hand 2.0
提出了一种具有全新驱动方式的Hand 2.0，适应不同个体，手的抓握增加左右方向的转动



Rehabilitation manipulator system based on imitation learning

历经2年多研发，成功研发基于模仿学习的安全、高效、人性化的辅助康复机械手系统



Product Challenge/产品挑战

Hand rehabilitation is becoming increasingly important

/手部康复越来越重要

data source: IFR, KPMG

数据来源：国际机器人学联合会、毕马威咨询公司



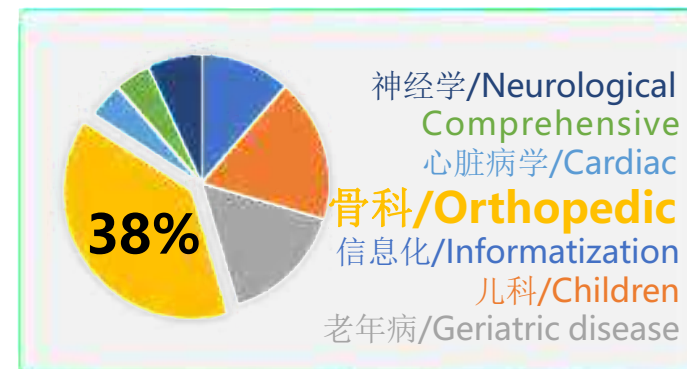
sport injury
/运动损伤

chronic pain posture optimization
/慢性疼痛 /姿势纠正

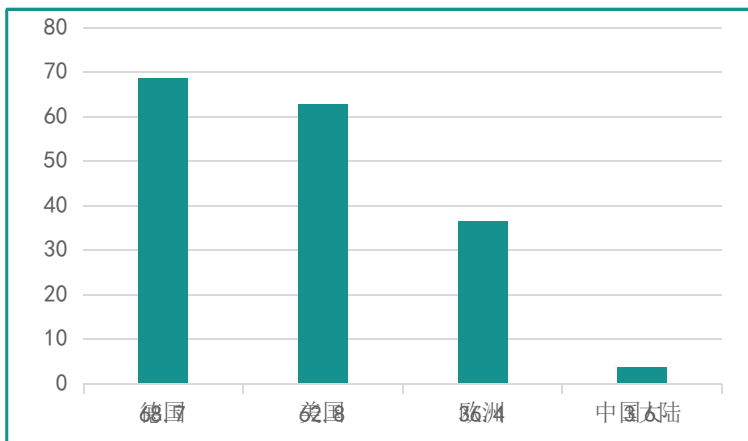


Rehabilitation Robot
/康复机器人

rehabilitation manipulator
/康复机械手



Direction map for use of rehabilitation robots
/康复机器人的使用分布图



The number of rehabilitation therapists per capita
/10万人均拥有康复师数量



3.6 rehabilitation therapists for every 100k people in China, well **below** the world average of **26**.

/在中国每10万人口拥有**3.6**个康复治疗师，**远低于**世界平均水平**26**个。



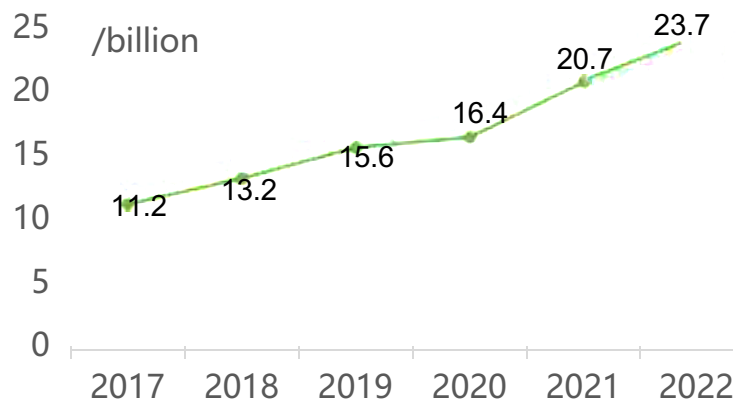
Combine **robot** and **medical** technology for **remote rehabilitation** and **centralized** rehabilitation.

/康复机器人有效结合**机器人**与**医疗**技术，替代康复治疗师繁重、重复的机械性重复训练操作，有助于实现**远程**康复和**集中化**康复医疗。

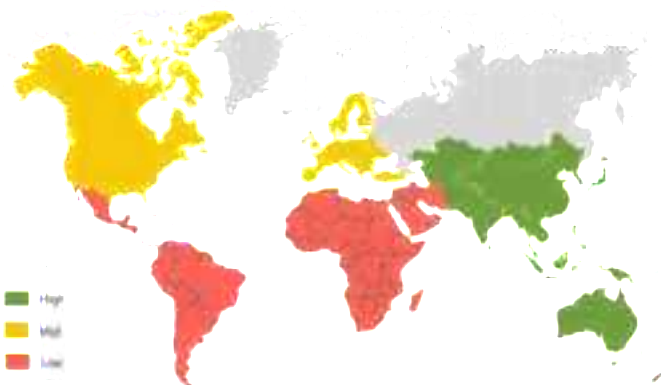


Market Background/市场背景

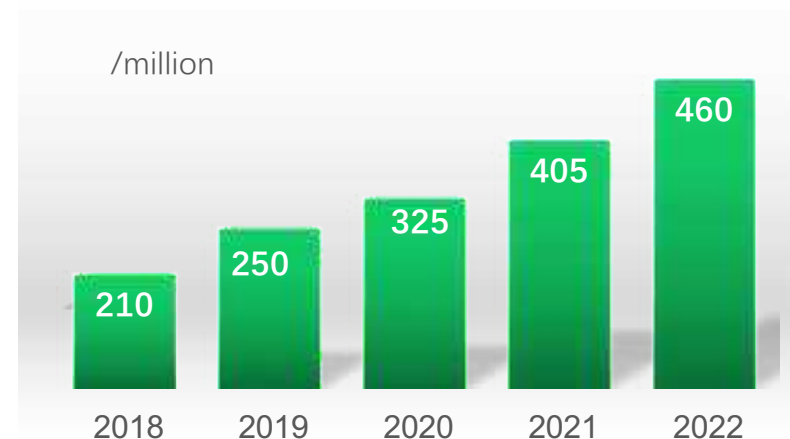
Data source: China rehabilitation robot market research and Investment strategy report
/数据来源：中国康复机器人市场调研与投资战略报告



Global rehabilitation robot sales (industry size)
全球康复机器人销售额（行业规模）2017-2022



Rehabilitation Robots Market-Growth Rate by Region/各地区康复机器人市场增长率(2017-2022)



The market size of the rehabilitation robot industry in China /中国康复机器人行业市场规模 2018-2022

In 2024 the global rehabilitation robot market will reach **\$100 + billion**,

2024 年全球康复机器人市场可见空间达 **\$1000+ 亿美元**

Customer population will reach **120+ million**, 客户人群规模达到**1.2亿**

The CAGR will reach **24.51%**, 年复合增长率达到**24.51%(2021-2026)**



Pain Points & Solution/痛点&解决方案

High labor cost for rehabilitation therapists and few manipulators for hand rehabilitation.

康复医疗师人工 成本高，手部康复机器人少

The demand for sports rehabilitation is expanding for more exercising and sub-health conditions. However, professional therapists for hand rehabilitation lack and patients can't afford robots.

运动人群增多，受伤状况增多，亚健康状态 越来越常见，**运动康复的需求扩大**，专业**手部康复治疗**治疗师缺乏，人工康复治疗成本高。

Highly depending on the experience of therapists and is difficult to learn.

康复操作**依赖**治疗师**经验**手法，学习难度大

The individual situation of patients with hand injury is very different, so it is impossible to use unified movement for rehabilitation treatment. Rehabilitation operation is highly professional, and is difficult to teach and train.

手部受伤患者的**个体情况差异大**，无法用统一的动作进行复健治疗；康复操作**专业性高**，传授培训时间长，学习难度大。

Videodata relies on human monitoring.
康复过程主观评定，效果难以定量控制

Rehabilitation treatment requires a longer course of treatment, and improper operation is likely to lead to secondary injuries. Now it generally depends on the subjective judgment of the therapist, and the therapeutic effect cannot be quantified uniformly.

康复治疗需要较长疗程，若操作不当容易导致二次受伤。现在一般依赖于康复师**主观判断**，**治疗效果无法统一量化**。

1

Security/设备安全性高

Polymer organic manipulators fit human bones gap well. Multimodal sensors reduce probability of error and the cost of hand rehabilitation, while improving device safety.

高分子有机机械手可以贴合人体手部。**多模态**传感器降低错误发生概率，**降低**手部康复治疗的成本，提升了设备安全性。

2

Effect/治疗效果好

Parameterized skill learning method is proposed to learn multiple texts through machine learning method to reduce training time of therapists. Real-time human-computer interaction stimulates patients' enthusiasm and actively integrates into the treatment process.

提出**技能参数化学习方法**描述治疗师的经验操作，通过机器学习方法进行**多样本模仿学习**，减少“康复师”**培训时间**。人机实时交互激发患者热情，主动融入治疗过程。

3

Experience/效果评价准

The rehabilitation action data and the patient response data during the operation were recorded, evaluated with CARF international standards for rehabilitation to evaluate rehabilitation status of patients in real time and feed back to the rehabilitation therapist.

记录康复机器人的动作数据和治疗过程中传感器返回的患者反应数据，根据**CARF认证康复国际标准**，**实时定量评价**患者的康复情况并**反馈**给康复治疗师。



Main Product/主要产品

Rehabilitation manipulator system based on imitation learning/基于模仿学习的辅助康复机械手系统

Hardware manipulator 硬件机械手



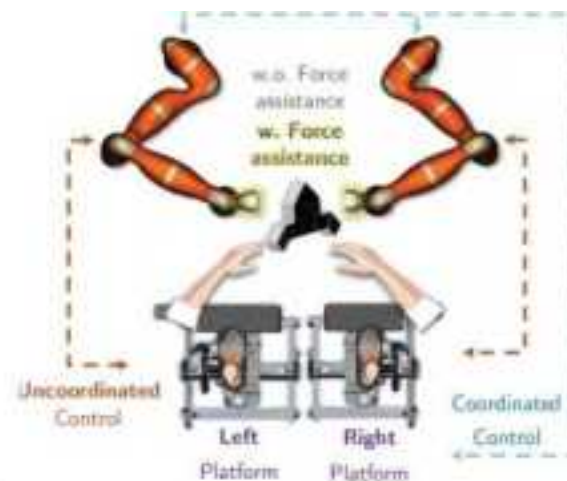
Polymer organic manipulators /高分子有机机械手
Multimodal sensors with angle and torque sensors
/多模态传感器实现位置、速度和力矩控制
Unified interface package/统一接口套件

Basic rehabilitation system 基础复健系统软件—手复云



Regular rehabilitation modes with parameters as
arm length and arm circumference/ 选择基本复健
动作模式, 输入人体参数, 实现常规复健动作
Real-time human-computer interaction /人机实时交互
界面帮助患者实时掌握治疗过程和效果

Customized Solution 定制化康复方案



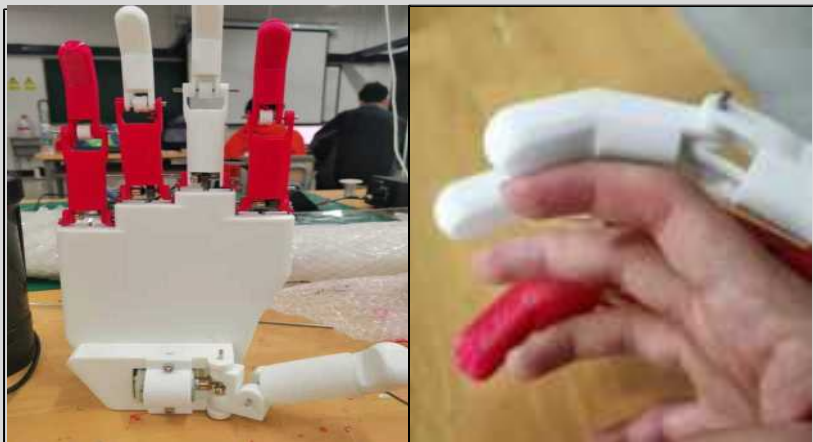
Meeting individual requirements /满足个性需求
Independent imitation learning with parameterized
skill learning method to adjust the range of action/
技能参数化方法学习治疗师的经验操作, 自主实现模
仿学习, 调整动作幅度



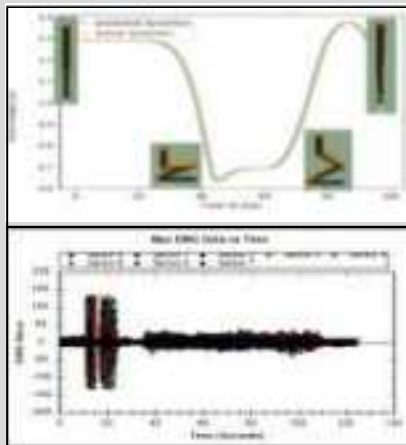
Core Technology/核心技术

1. Polymer manipulator and universal hardware interface / 高分子机械手和普适硬件转接口

- Customized polymer organic manipulator, equipped with mechanical pressure feedback device, to realize the non-gap fit between rehabilitation manipulator and hand/定制化高分子有机机械手，配备机械式压力反馈装置，实现康复机械手与手部无间隙贴合。
- Improved hidden state algorithm based on Kalman to integrate torque and angle data for confusion control. Increases the intelligence degree of the manipulator and reduces the risk of error/通过基于卡尔曼的改进隐状态算法，有效融合力矩和角度数据，在位置、速度控制上匹配力矩控制，增加机械手的智能程度，减少错误风险。
- Unified SVAC->RTSP standardized data format to achieve a unified software interface, integrated hardware interface to achieve an extensible hand recovery system. /统一的SVAC->RTSP标准化数据格式实现统一软件接口，集成的硬件转接口实现可扩展手部复健系统。



Polymer manipulator with mechanical pressure feedback device
/具有机械式压力反馈装置的高分子机械手



Force & Angular sensor data fusion
/力矩和角度传感器数据融合算法



Different sensor and manipulator adapter
/不同传感器和机械手转接器件



Core Technology/核心技术

2.Skill parameterization algorithm for autonomous learning/自主学习的技能参数化算法

1



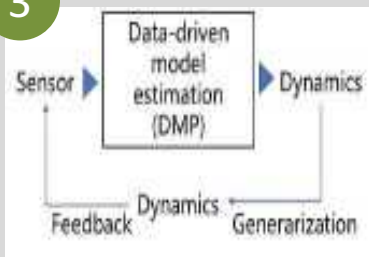
The skill parameterization algorithm of self-learning is combined with **mediapipe** for gesture recognition
自主学习的技能参数化算法结合 **mediapipe** 进行手势识别

2



Record the rehabilitation action plan given by the rehabilitation therapist
记录康复治疗师给出的复健动作方案

3



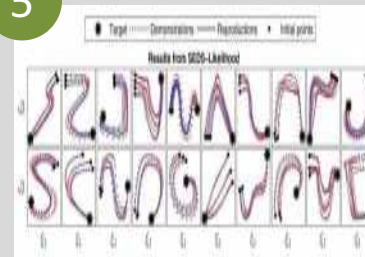
Parameterized action data can be adjusted adaptively according to different individuals
参数化动作数据、根据不同个体实现自适应调节

4



Mimicking the movements of a physical therapist
模仿学习复健治疗师的动作

5



Control and adjust the strength and speed of rehabilitation for each part of the patient.
控制**调整**患者每个部位的复健力度、速度

Technical support for five fingers and gesture tracking, high accuracy, effective implementation of adaptive rehabilitation treatment for different patients

技术支持五指和手势追踪，**准确率高**，有效实现对不同患者的**自适应**复健治疗方案



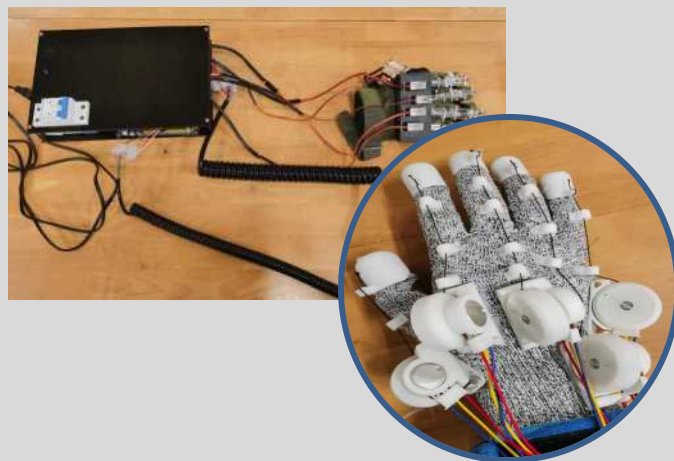
Core Technology/核心技术

3. Personalized and customized working mode/个性化定制的工作模式

Finger bend detection mode/手指弯曲检测模式

By processing the data of voltage and finger bending degree, it can be converted into the output finger bending Angle, and then the data is transmitted to the upper computer program.

通过对电压大小和手指弯曲程度的数据进行处理，可以转换为输出手指弯曲角度的大小，而后将数据传输给上位机程序。



Finger curvature detection
手指弯曲检测

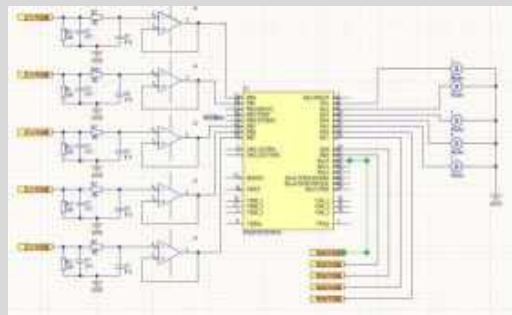
XCOM V2.6	
大拇指检测电压值为: 2.95V	食指检测AD值为: 2343
食指检测电压值为: 1.89V	中指检测AD值为: 2285
中指检测电压值为: 1.82V	无名指检测AD值为: 0
无名指检测电压值为: 0.00V	小指检测电压值为: 0.00V
压阻杆 7113	设计检测电压值: 0.00V
大拇指检测AD值为: 3856	食指检测电压值为: 1.85V
中指检测AD值为: 2285	中指检测电压值为: 1.84V
无名指检测AD值为: 0	无名指检测电压值为: 0.00V

Finger dynamic information collection
手指动态信息采集

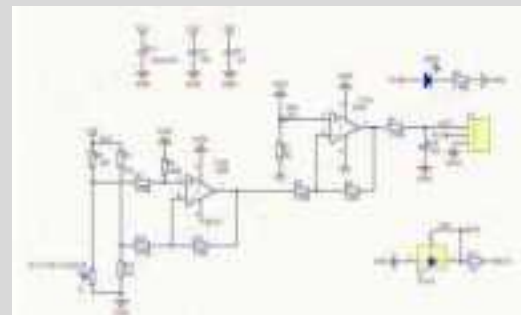
Rehabilitation exercise mode/康复运动模式

As a driving device, the manipulator needs to drive the finger to move, which is suitable for use when the finger cannot move and needs to be rehabilitated by external forces.

机械手作为驱动器件，需要带动手指进行运动，适用在手指无法运动，需要借助外力进行康复时使用。



Sensor schematic diagram
传感器原理图



Schematic diagram of manipulator circuit
机械手电路原理图



Patent Situation/专利情况



An improved multi-RRT path planning algorithm based on fusion prediction



A high sensitivity pulse optical pumping scalar magnetic field measuring device and the method



A cartridge manipulator with interchangeable fingers



A magnetic field active compensation system controlled by a mechanical arm and a method



A haptic shape recognition and grip optimization algorithm



Query small program system based on time series prediction

Our team own

5 Invention patents

(5项发明专利, 2项已授权, 1项团队成员为第一发明人)

1 software copyrights (1项软件著作权)

Patents refer to

1. An improved multi-RRT path planning algorithm based on fusion prediction (一种融合预测的改进Multi-RRT路径规划算法) —— **Authorized (已授权)**
2. A high sensitivity pulse optical pumping scalar magnetic field measuring device and a method. 一种高灵敏度脉冲光学泵浦式标量磁场测量装置及方法 —— **Authorized (已授权)**
3. A cartridge manipulator with interchangeable fingers (一种可换指的卡盘型机械手)
4. A haptic shape recognition and grip optimization algorithm (一种基于触觉的形状识别和抓握优化算法)
5. A magnetic field active compensation system controlled by a mechanical arm and a method (一种机械臂控制的磁场主动补偿系统及方法)

Software copyrights refer to

1. Query small program system based on time series prediction (基于时间序列预测的查询小程序系统)



Cooperation/合作案例



HuaAn Medical 华安医疗

- ◆ The company has **a number of Class II medical device products**, has obtained ISO13485 quality system certification, Ecstoc **CE certification** and US **FDA certification**
- ◆ 该公司拥有**多个II类医疗器械产品**，已获得**ISO13485**质量体系认证、欧共体**CE认证**和美国**FDA认证**。



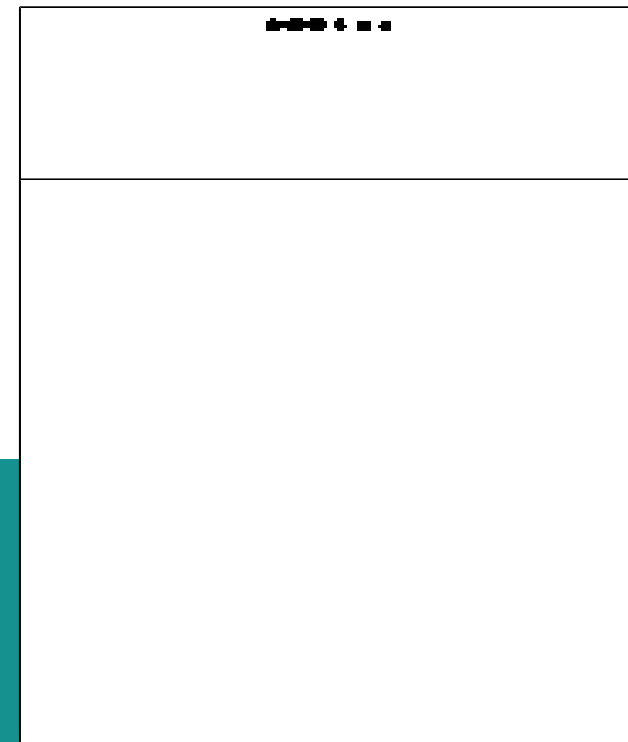
Product fair and company cooperation
产品洽谈会



customized solutions discussion
团队研讨试用的定制方案



Product launched to Huaan Medical
定制试用产品入厂



Purchase Intent : ¥460,000 yuan.
5 sets of basic hand rehabilitation system platforms (personalized rehabilitation programs)
8 sets of hardware universal interfaces

已签订采购意向书，金额**46万**，包含基础手部复健系统平台**5套**（包含**个性化复健方案**），硬件通用接口**8套**。



Core Technology/项目进展

2023.08

Apply for company registration

申请注册公司

- ◆ The company's relevant materials have been prepared
已经准备好公司相关材料
- ◆ school 's co-working space 已入驻学校众创空间

项目持续推进，规划目标清晰

2023.10

Apply for a Class II medical device

申请II类医疗器械——免临床、创新器械

- ◆ The fastest registration time is 85 days according to "Special Approval Procedures for Class II Innovative Medical Devices" (Zhejiang FDAR [2016] No. 2) 符合原浙江省食品药品监督管理局（现省药品监督管理局）《第二类创新医疗器械特别

审批程序》（浙食药监规（2016）2号），器械获批注册证最快仅需85天

- ◆ 15-04-01 Electrical patient surgical position fixation assistive device category in "Catalogue of Medical Devices Exempted from Clinical Evaluation "(SFDA No. 71 [2021])

属于国家药监局（2021年第71号）《免于临床评价医疗器械目录》

15-04-01 电动患者手术位置固定辅助器械 类目



2024.10

Product launch 产品上市





Team Members/团队成员

Multi-Disciplinary and International/多学科国际化校友团队
Reasonable distribution of members, technology & market/技术&市场兼顾



Executive Director

Liu Wei

- CY Cergy Paris University/塞尔齐-巴黎大学
- Civil Engineering and Architecture/土木工程
- President of the school Volunteer Association/校志愿者协会主席
- One year internship in Derhe Rehabilitation Company /蝶合康复公司实习一年
- Serial entrepreneur with family support/曾创立“药购”在线平台



Co-Founder

Yu Jiachen

- CY Cergy Paris University/赛尔齐巴黎大学
- Civil Engineering and Architecture/土木工程
- Zhejiang Sofo Internet Medical Technology Co., LTD. Assistant general manager/浙江搜弗互联网医疗科技有限公司总经理助理
- "Karl Marx Cup" Zhejiang University students theoretical knowledge competition second prize/“卡尔·马克思杯”浙江省大学生理论知识竞赛二等奖



Technical Manager

Mo Ruiqi

- CY Cergy Paris University/塞尔齐-巴黎大学
- Civil Engineering and Architecture /土木工程
- Provincial government scholarship/省政府奖学金
- Rehabilitation Company/天瑞康复公司实习一年
- University-level first-class scholarship/校级一等奖学金



Marketing Manager

Zhou Jiahao

- CY Cergy Paris University/塞尔齐-巴黎大学
- Civil Engineering and Architecture/土木工程
- One year internship with industry leaders including Yongtop Technology company /在yongtop 科技实习 一年



Product Manager

Shen Yuxuan

- CY Cergy Paris University/塞尔齐-巴黎大学
- Civil Engineering and Architecture/土木工程
- National innovation projects/多项学生科研创新项目
- ZUST Volunteer Director/ZUST志愿者负责人
- One year internship in Intel Company/英特尔公司实习一年



Technician

Shen Hongru

- CY Cergy Paris University/塞尔齐-巴黎大学
- Civil Engineering and Architecture/土木工程
- Chairman of the Party Member's Home Management Committee/党员之家管理委员会主席
- One year internship in Tianrui Rehabilitation Company/天瑞康复公司实习一年



Experts/专家团队



Professor Zhang Yun /张云教授

- Member of the Logistics Engineering Branch of the Chinese Society of Mechanical Engineering
/中国机械工程学会理事
- Executive Director of logistics engineering branch of Zhejiang Mechanical Engineering Society
/浙江省机械工程学会常务理事

Professor Bernd Noche

- Chairman of the Technical Committee on Intelligent Logistics and Industrial Clusters of German Industry 4.0/ 德国工业4.0智能物流及产业集群技术委员会主席
- With more than 30 years of experience in logistics and supply chain optimization and design
/拥有30多年的物流和供应链优化设计经验



Zheng Hongbo /郑洪波 浙江国自机器人技术股份有限公司 董事长

- National Plan of people choice
/国家万人计划入选者
- Head of the national specialized new "Little Giant" enterprise
/国家级专精特新“小巨人”企业负责人
Winner of the second prize of the National Science and Technology Progress Award
/国家科技进步二等奖获得者



Competitive Product Analysis/ 竞品分析

	Domestic companies /中国公司	Foreign companies /欧美公司	Future company 我们团队
Company 公司			
Business 业务	Provide rehabilitation medical services for hospitals, nursing homes or individuals. These companies are then constantly optimizing their products and expanding their range of services to provide better assistance to patients. 为医院、养老机构或者个人提供康复医疗服务，这些公司再不断优化自己的产品，扩展自己产品的服务范围，为患者提供更佳帮助	These enterprises have absolute industry status and strong hardware production platform, the annual revenue is global top 5, large-scale intelligent upgrading in many fields. 这些企业已拥有绝对的行业地位和强劲的硬件生产平台，年产值全球前五，在多领域大规模向智能化升级。	We specialize in hand rehabilitation and provide personalized services to people who suffer from finger injuries to help them better recover their fingers. 我们专注于手部康复治疗，并为受困于手指伤病的人们提供个性化服务，帮助其更好得手指康复。
Hardware 硬件	Medical equipment for upper and lower limb rehabilitation. 上肢与下肢康复医疗设备 Single use price: 200~300/half an hour (单次使用价格) 500,000~2,000,000/set (全套)	Medical equipment for upper and lower limb rehabilitation. 上肢与下肢康复医疗设备 600,000~1,000,000/set 60万到100万区间每套产品	An exoskeleton finger device that simulates the medical techniques of a rehabilitator, Unified interface hardware and software interface. 模拟康复师医疗手法的外骨骼手指设备，统一接口软硬件接口。 Finger device 5,000/set 手指设备5000每套
Software 软件	According to the specific plan pricing, generally more than 200,000. 根据具体方案定价，一般20万以上。	According to the specific plan pricing, generally more than 400,000. 根据具体方案定价，一般40万以上。	User-specific solutions solutions, basic software (including software interface platform) of 8,000/ set, customized solutions of 5000/ set. 用户定制化方案，基础软件（含软件接口平台）8,000/套，定制方案5000/套。

Independently developed system for standarization, intelligence and customization.

/ 自主开发的硬件、软件和算法，实现**标准化、智能化、个性化**康复治疗



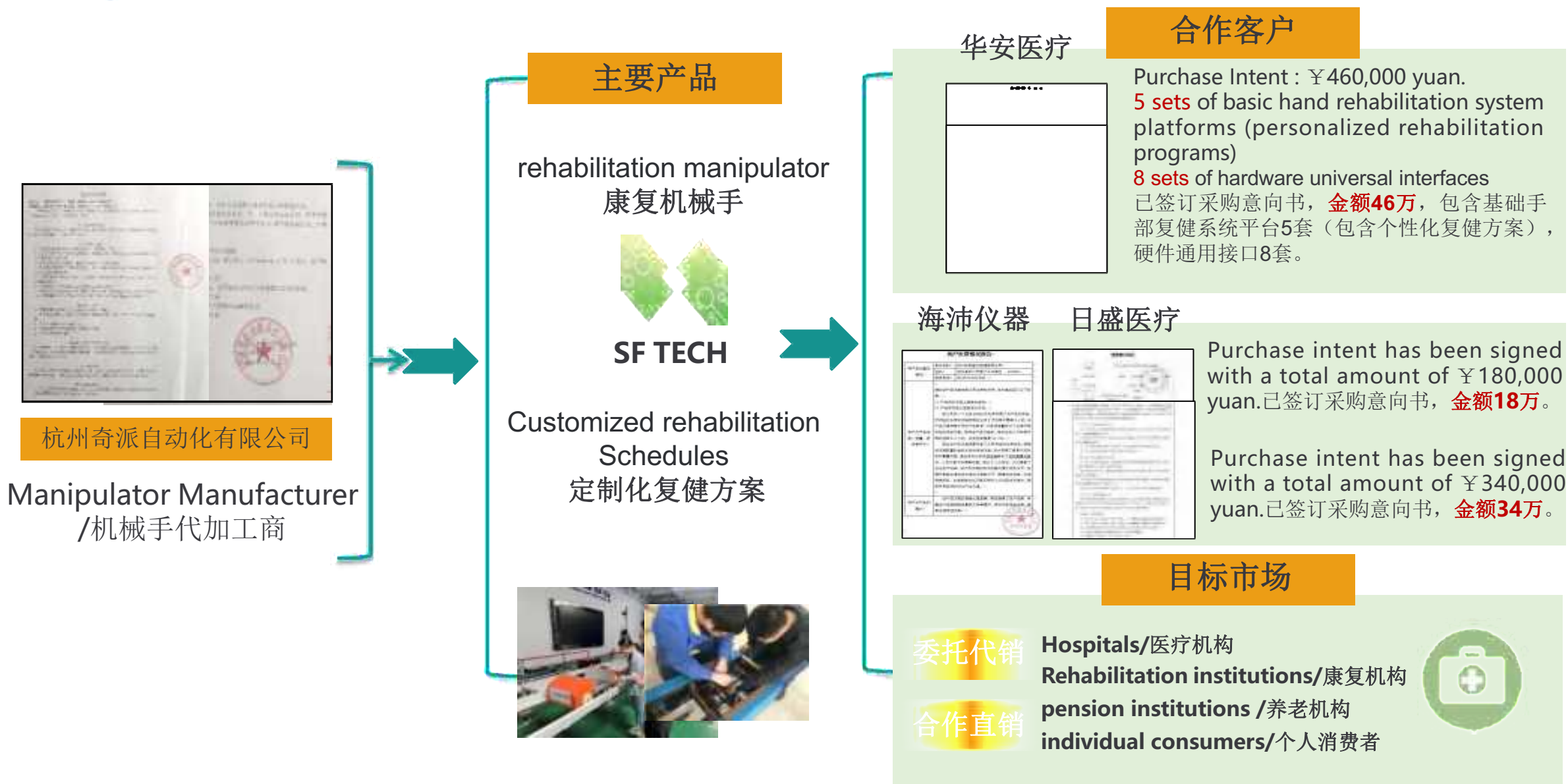
Business model/商业模式



以功能改善为依据的打包支付模式——成本-功能改善最大化，

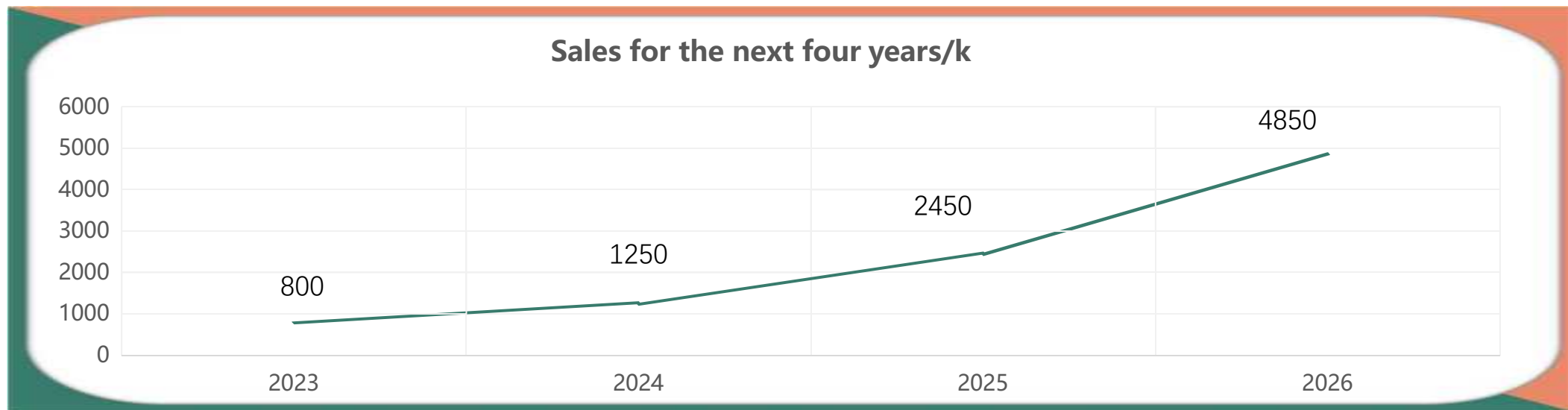


Business model/运营模式





Financial Forecast/财务预测



Y2023

Initial stage with ¥ 800k revenue
/营收 80 万元人民币

Y2024

Development stage with ¥ 1250k revenue
/营收 125 万元人民币

Y2025

Expansion stage with ¥ 2450k revenue
/营收 245 万元人民币

Revenues will add up to **¥9,350,000** in 4 years /预计四年内将累计至¥935万元

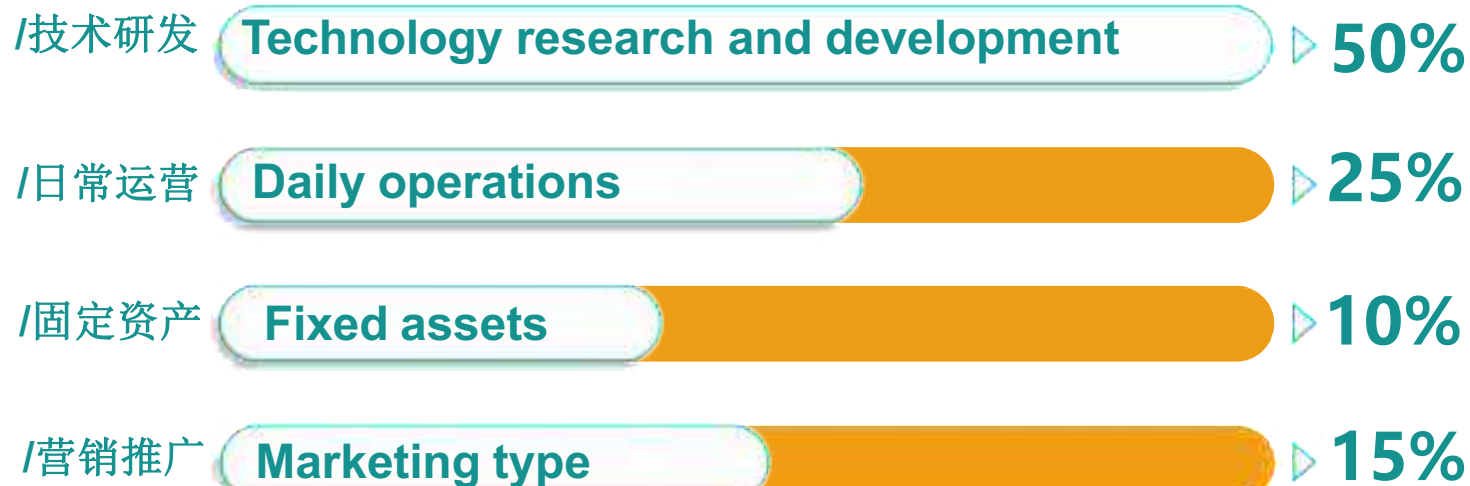
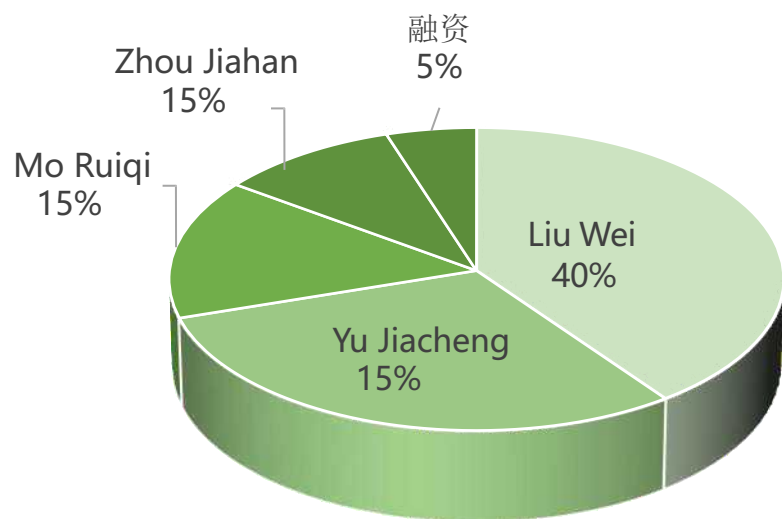


Financing Program/融资计划

First round of financing **¥1500,000**, release of Equity **10%**

/第一轮融资¥1500,000, 释放股权10%

Capital Structure /股权结构





Marketing Strategy/市场策略

01 Attend academic conferences /学术会议

International and domestic conferences on artificial intelligence and rehabilitation therapy

/多次参加人工智能、康复医疗相关的国际和国内的高端会议



2022 康复设备与解决方案展览会 (REHACARE SHANGHAI)



02 Smart Exhibitions /智慧展览

The 9th Shenzhen International Artificial Intelligence Exhibition in 2021

/团队参加了2021年第九届深圳国际人工智能展览会，为项目发展客户



03 Industry Association /行业协会

China Association of Assistive Products

/中国康复辅助器具协会

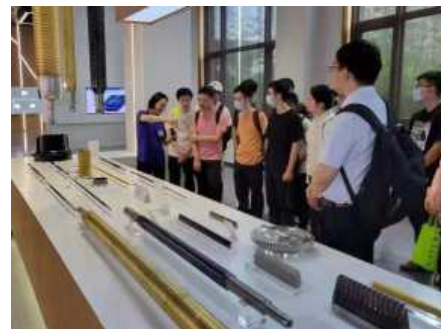
China Chinese Association Of Rehabilitation Medicine

/多次受邀参加中国康复医学会学术研讨

04 Push with precision /精准推送

Visit the relevant companies, take the initiative to promote the company's business

/参观相关公司，主动推动公司业务





Promoting Education/引领教育



• 实践引领教育

- “Safe fingers” innovation base/建立“手复科技”创新基地
- 13 Lectures/开展13次智能机器人讲座（包含8次线上）吸引2000余名学生
- Voluntary teachers/担任杭州市青少年活动中心“智能机器人”课程志愿教师

- 7th Robotic Summit/ 参加第七届“中国机器人峰会”
- Scientific practices/结题大学生科研计划5项（国家级1项）
- Academic conference/参加学术会议10余次并做2次报告
- Graduation projects/结题本科生毕业设计5项



• 科研引领教育



• 产业引领教育

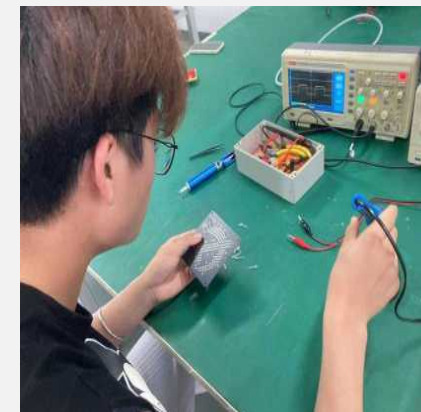
- Enterprise Practice Base& vocational training/在合作企业华安医疗公司建立了“企业实践基地”，已为我校学生开展10次职业培训，累计200余人次
- Employment/已有十余名学生至合作企业工作
- Business Incubation Fund/获得“青春均胜”创业孵化基金



Talent development/人才培养

反哺校园

Feeding back to the campus



算法学习课程
Algorithmic learning courses



机械手电路学习
Manipulator circuit learning

参观、学习医药制品工厂
Visit and learn about
pharmaceutical product
factories



导师与学生讨论算法问题
Tutors discuss
algorithmic problems
with students





Promoting Employment/带动就业

直接 带动

- The company is expected to be established in August this year with 15 staff members
/今年8月成立公司，成员15人
- **Employ 50 staffs and create 3,000 jobs indirectly, in 5 years**
/未来5年直接带动就业50人，间接带动就业3000人

间接 带动

Upstream /上游

Hardware production suppliers

Network construction service provider

推动硬件生产供应商、网络建设商等行业的发展

Downstream /下游

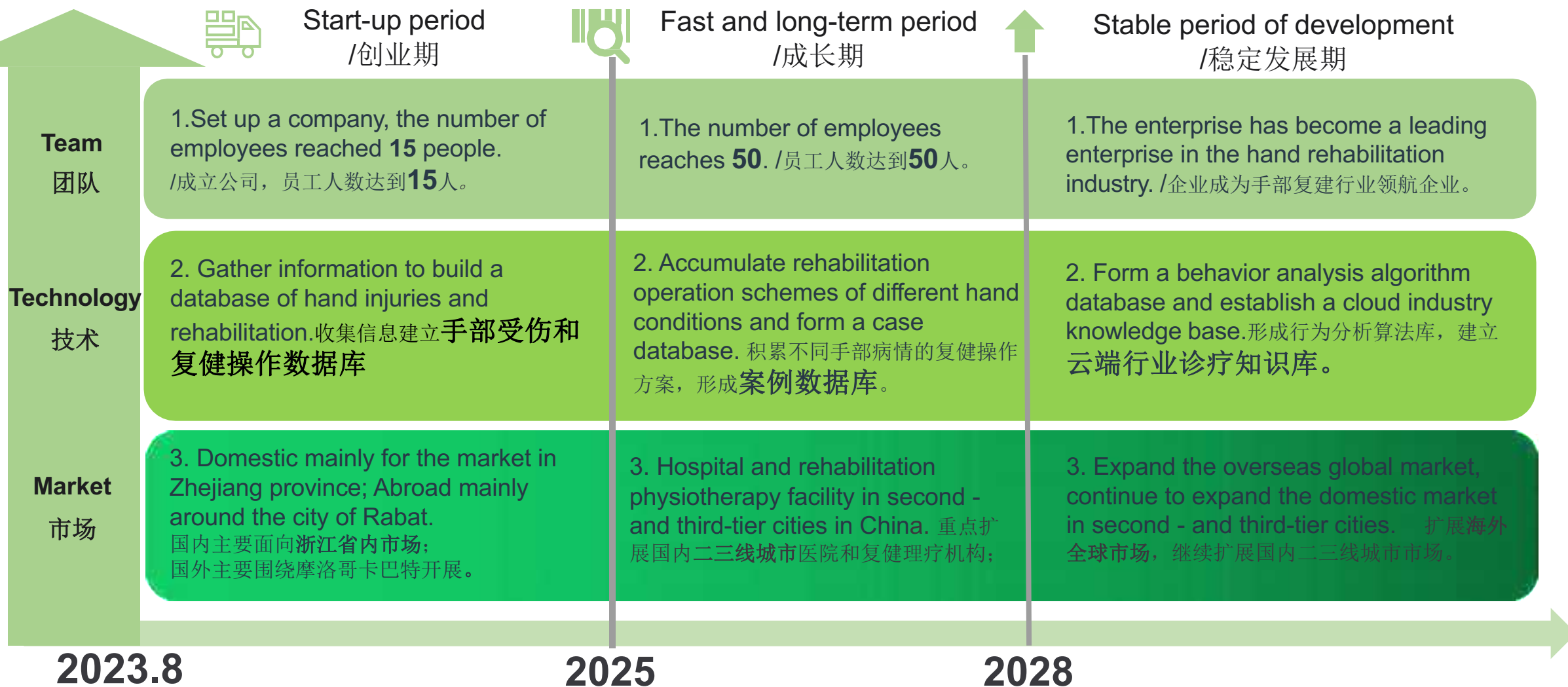
Intelligent equipment maintenance staffs,
Algorithm developer etc.

带动智能设备维护人员，算法开发人员等工种发展

200 schools ,3000 employees in the next 5 years
预计五年布局100个学校和康复机构，带动就业3000人



Development Planning/发展前景



Customized professional rehabilitation therapists /持续研发，打造个性化定制的手部复健专业治疗师

手复

safetingers

Leader in hand rehabilitation industry

手部复健行业领航者



- International Lane（国际赛道）
- Category: Undergraduate Creativity Group
- Founder: Liu Wei
- School: Zhejiang University of Science and Technology